



IN-OVO INCULCATION OF SELENIUM NANOPARTICLES IMPROVES PRODUCTIVE PERFORMANCE, BLOOD BIOCHEMICAL PROFILE, ANTIOXIDANT STATUS AND IMMUNE RESPONSE OF HATCHED CHICKS

[81]

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ABSTRACT

Selenium is a trace element essential in animal nutrition and exerts multiple actions related to enhance animal production, fertility, immune response and antioxidant defense system of chickens. The aim of the present study is investigating the benefit effects of selenium nanoparticles (SEN) in-ovo injection on productive performance, express stimulate antioxidant defense system and immune response of hatched chicks. A total of 210 broiler breeder eggs (Habbard Star-Bro) were divided into three in-ovo injection treatment groups, (0, 5 and 10 ppm SEN) and incubated. Hatchability traits, productive performance, biochemical profile, antioxidant status and immune response of hatched chicks were estimated. Results indicated significant increase in HDL-cholesterol, T3, GSR, GSH, IGA, IGM and IGG as affected by in-ovo inoculated SEN levels. However feed conversion ratio, triglycerides and MDA significantly decreased by in-ovo treatments. No significant alternations were recorded in hatched chicks weight, feed intake, body weight, body weight gain, carcass characteristics, and serum levels of protein fractions, cholesterol, LDL-cholesterol, ALT, AST, ALP, uric acid, creatinine and glucose in in-ovo treated groups compared with the control one. It is summarized that, in-ovo inoculation of different levels of SEN can improve feed conversion ratio, lipid profile, antioxidants status and immunity of broiler hatched chicks.

Keywords: Selenium; Chicks; Fertility

INTRODUCTION

Selenium is a trace element essential in animal nutrition and exerts multiple actions related to animal production, fertility, and disease prevention. In addition Selenium (Se) is well known to be essential for growth (Yoon et al 2007, Wang and Xu, 2008), feather development (Edens et al., 2001, Perić et al 2009) of chickens. Previous studies have also shown that Se injected into the egg is potentially toxic to chick embryos. (Macalintal, 2012), reported that, The effect of injecting graded levels of Se at 20, 40 and 60 µg/egg either as Se-Met or Na₂SeO₃ did not produce any physical deformities in embryos by d 18 and 20 of incubation, as shown the 60 µg Se dose, % livability was higher ($P < 0.05$) for embryos injected with Se-Met compared with Na₂SeO₃. In another study to the same author with broiler eggs using injection doses up to 40 µg Se/egg, Se-Met injection resulted in higher hatchability. Numerous reports have demonstrated that selenium was the co-factor and activator of 5' deiodinase that was a key enzyme of triiodothyronine (T3) synthesis, and T3 was the growth control component of animals particularly poultry by controlling the body's energy and protein assimilation, and thus could regulate animal growth (Özbal et al 2008). Selenium is an essential trace element that up regulates a major component of the antioxidant defense mechanism by controlling the body's glutathione pool and its major Se-containing antioxidant enzyme. Approxi-

mately 30–40% of selenium exist in the form of GSH-Px in animal body tissue, and lots of animal diseases and dysfunction were caused by GSH-Px activity change that aroused by selenium deficiency (Pilarczyk et al 2012). Dietary selenium is essential for the activity of virtually all arms of the immune system (Surai and Dvorska, 2002). (Levkut et al 2009) suggested that the effect of organic Se in increasing the concentration of circulating T and B cells is important in restoring the leukocyte subpopulation in chicks fed a deoxynivalenol (DON) contaminated diet, leading to increases in cellular phagocytic activity.

MATERIAL AND METHODS

The aim of this study was to investigate the effect of selenium nanoparticles (SEN) in-ovo injection on productive performance, express stimulate antioxidant defense system and immune response of hatched chicks. A total of 210 broiler breeder eggs (Habbard Star-Bro) were obtained from a local hatchery (El-Tokhy Co., New Salhia, Egypt) from a maternal flock 54 week of age. Eggs were incubated at 37.8°C and 60% RH. Eggs were individually weighed and divided into three treatment groups, with approximately similar average egg weight per group (56.5±0.2 g). The first treatment non ovo-injected, and considered the control group, where the second and the third treatments were ovo injected with 100µL of nano-Selenium enriched yeast with concentrations of 5, 10 ppm respectively. Nano – Selenium was obtained from Department of physics, Faculty of Science, Mansora University, Mansora, Egypt.

Eggs were candled at day 7 and 14 of incubation and either unfertilized or died embryos were removed. Those eggs containing live embryos were randomly re-allotted eggs to the experimental groups equally (65eggs in each). At 14 day of incubation, all eggs in the second and third groups were injected with 100 µL of their respective solution into the air cell according to the procedure described by (Bhanja et al 2004). Prior injection, both of the working bench and the eggs were disinfected with 70% ethanol and the shell was punched at the width end of the egg to make a hole with a 21-ga needle. Then, the eggs were injected with a 23-ga needle. At day 21 of incubation, hatched chicks, within each treatment group, were individually weighed then its respective values and values of hatchability were recorded.

Experimental birds and diet

The hatched chicks, from each treatment were immediately assigned to three pens per treatment (100 × 60 × 50 cm; length × width × height), with *ad libitum* access to water and feed, at the same managerial, controlled, clean and hygienic environmental conditions. Vaccination against the Newcastle disease (ND) virus was performed on days 21 and 28 of age using an eye dropper (Live Lasota strain; KBNP, Inc.; Hungnam, Korea). Artificial light source was used in order to provide 24 hours of light per day throughout the first week, then reduced to 22 h for the other experimental periods.

The experimental basal diet was purchased from Salah Attia Co.,

Tafahna El-Ashraf, Egypt, which formulated to meet the recommendations of (NRC, 1994). The composition and calculated chemical analysis of the basal diet are presented in **Table (1)**.

Measurements

Hatchability and embryonic mortality

Hatchability percentage was recorded and calculated as follows:

Hatchability (%)=

$$\frac{\text{Number of hatched chicks}}{\text{Number of fertile eggs prior to injection}} \times 100$$

Growth performance parameters

Live body weight (LBW) per replicate was individually recorded once weekly in early morning. Average daily body weight gain (BWG) was weekly calculated as the difference between current and previous weight divided by seven days. Daily feed intake (FI) and feed conversion ratio (FCR) per bird were calculated weekly. Overall BW gain, FC, and FCR were calculated for the whole duration of the experiment. At 35 day of age, six representative birds were randomly taken from each treatment group, fasted for 12 hours before slaughtering, individually weighted. Birds were manually slaughtered by cutting the jugular veins of the neck by sharp knife, and the slaughtered birds were defeathered, opened and the hot carcass was weighted. Edible offals were weighted as proportional value to live pre-slaughtering weight. Carcass yield was calculated as follows:

$$\text{Carcass yield} = \frac{\text{Empty carcass weight (g)} + \text{edible offals weight (g)}}{\text{Live pre-slaughtering weight}} \times 100$$

Biochemical parameters

At the end of the experimental period, six chicks from each group were randomly chosen and scarified in a horizontal position to reduce the antiperistalsis movement of intestinal segments and regurgitation of their contents. Birds were sacrificed, bled individually into siliconized tubes. Upon coagulation blood were centrifuged at 4000 rpm for 15 min. The serum was separated from the other tube stored in deep freezer at (- 20°C) until the biochemical analysis. The following biochemical parameters were determined: aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP), uric acid (UA), creatinine (CR), glucose and antioxidant parameters were determined spectrophotometrically using commercial kits as described by the manufacturer company (SpinreactCo., Spain) according to (Ishihard et al 1972). Serum total proteins values (g/dl) were obtained according to the method described by (Henry, 1974). Serum cholesterol, HDL and LDL-cholesterol (mg/dl) were determined according to the method of (Richmond, 1973). Triiodothyronine (T3) were determined by using Gamma-Coat 125I RIA Kits, according to (Britton et al 1975). Serum IgA, IgM, and IgG concentrations was recorded as total serum Ig concentration (Mountzouris et al 2010).

Statistical analysis

Data of the experiment for all variables were subjected to ANOVA as a completely randomized design according to (Snedcor and Cochran, 1982), Procedure of the Statistical Analysis System (SPSS, version, 18.0; 2010). The following model was used: $Y_{ij} = \mu + T_i + e_{ij}$, where: Y_{ij} = An observation, μ = general mean, T_i = fixed effect of ied treatment levels (i = 0, 5 and 10 PPM), e_{ij} = Experimental error of the model. Differences among treatments were tested statistically with New Multiple Range test method according to (Duncan, 1955).

RESULTS AND DISCUSSION

Hatchability, embryonic mortality and chicks body weight at hatch

Hatchability (%) and body weight at hatch (BWH) are presented in Table (2), it is clearing from the data illustrated in the table that, hatchability and embryonic mortality rates were significantly affected by inovo injection nano- Selenium (Se) for broiler eggs. The control group recorded the highest hatchability value, while the 10 ppm inovo nano-Se group recorded the lowest hatchability percentage, followed by the 5 ppm nano-Se group, however, chick body weight had no significant differences between the treatments group and the control one. Although selenium had been credence as an essential trace mineral in poultry nutrition, dietary Se deficiency in poultry can lead to symptoms such as reduced fertility and reduced hatchability as well as reduced egg production (Latshaw et al 2004). Therefore, Se must be used in a limited levels because Se injection into the egg with relatively high doses may be exert a potential toxic effect to avian embryos. Our injection doses were in the limit levels not over doses, it had not find any abnormalities, such as inflammation of the neck and head region, as well as beak, leg and toe deformities, but the reasons for these different results can be attributed to many factors such as delivery technique, mineral form, day of incubation, route of injection (air cell, amnion or yolk) and inoculated dose. In agreement with our results, (Macalintal, 2012) indicated that, the effects of graded doses (0, 2.5, 5, 10 and 20 µg/egg) of Se either Se-Met or Na₂SeO₃ injection on embryo viability 10 d post-Se injection was embryo viability ranged from 84 to 97% for eggs injected with graded doses of Se-Met and from 74 to 94% for those injected with Na₂SeO₃. The same author in another study find that injection graded levels of Se up to 60 µg/egg either as Se-Met or Na₂SeO₃ did not produce any physical deformities in embryos by d 18 and 20 of Incubation.

Live body weight and body weight gain

Table (3), LBW was improved significantly (P<0.05) in the injected groups (R2 and R3) in the first week, and in the experimental periods but not significant. The highest values of LBW were

observed in R3. BWG was improved significantly ($P < 0.01$) in the injected groups (R2 and R3) in the all experimental periods, except the periods (8-14 and 22-28 day) and the total gain of live body weight but not significant. The highest values of BWG were observed in R2 and R3. The improvement in LBW and BWG may be due to the vital role of selenium, which can be summarized in that, selenium was act as a co-factor and activator of 5' deiodinase that was a key enzyme of triiodothyronine (T3) synthesis, and T3 was the growth control component of animals particularly poultry by controlling the body's energy and protein assimilation, and thus could regulate animal growth (Özbal et al 2008). In a study by (Jianhua et al 2000), Se-deficient chickens showed significant reductions in T3 and elevated T4 levels compared with Se-supplemented chickens. Likewise, 5' deiodinase activity was lower. Also, it may be due to the fact that, selenium deficiency lead to muscles destroy and supplementation of selenium not only prevent of this case, but also increase the rate of skeletal muscle breakdown. This is in agreement with (Brown et al 1981) who concluded that Se supplementation in rats increased muscle protein breakdown leading to heavier body weights. A similar trend was also reported by (Zhou and Wang, 2011) consisted of the basal diet supplemented with, 0.0, 0.1, 0.3, and 0.5 mg/kg of Nano-Se respectively, improved final BW, daily BW gain (DWG), feed conversion ratios, and survival rate ($P < 0.05$) were observed in the groups supplemented with nano-Se as compared with the control groups after 90 d of feeding.

Feed consumption and feed conversion ratio

feed consumption (FC) of broiler chicks was significantly ($P < 0.05$ and $P < 0.01$) changed as a results of *in ovo* injection with different doses of nano-Se, the FC values tended to increment in the injected groups specially in the all periods after hatch except the period 22-29 day and total feed consumption (TFC). While feed conversion ratio was significantly ($P < 0.05$ and $P < 0.01$) improved in the injected groups for the periods (15-21 and 29-35 day), and the total period but not significant. The improvement in feed efficiency resulting from utilization Nano-Se may be partially due to nano-Se exhibit novel characteristics such as a large surface area, high surface activity, high catalytic efficiency, strong adsorbing ability, and low toxicity (Zhang et al 2001, Wang and Xu, 2008). Also, organic Se is involved in regulation of enzymatic

systems interfering in energetic metabolism and metabolism of the essential fatty acids, purinic and pyrimidinic bases (Ebeid et al 2013). On the other hand, triiodothyronine is a main hormone controlling the body's energy and protein anabolism. In agreement with the present results, (El-Deep et al 2016), indicated that, feeding compound of Aspergillus awamori and Se nano-particles improved significantly feed conversion ratio and decreased feed intake in chickens.

Carcass characteristics

Carcass characteristics of Hubbard-Starbroiler broiler chicks are presented in Table (5), and it was showed that, all the examined carcass traits (carcass weight (%), breast weight (%), thigh weight (%), total edible weight (%), heart weight (%), gizzard weight (%), liver weight (%), spleen weight (%), thymus weight (%), bursa weight (%)) and carcass yield (%) were not affected significantly ($P > 0.05$) by *in ovo* injection with different doses of nano-Se. In line with the present results, (Khazraie et al 2015) indicated that no significant effect on carcass composition ($p > 0.05$) of chicks fed diets with Selenium Nano particles, sodium selenite and control, and increase in use of nano-Selenium was more tender than sodium selenite group, but not significant. On the other hand (El-Deep et al 2016) revealed that, high ambient temperature significantly depressed breast muscle weight, and abdominal fat weight, while feeding nano-Se clearly alleviated these negative effects of high ambient temperature. In the same trend, (Cai et al 2012) reported that, there were no significant differences ($P > 0.05$) in immune organ index (thymus, bursa, and spleen) of broiler chicks due to supplementation with nano-Se.

Biochemical parameters

Results of blood biochemical parameters are presented in Tables (6, 7, 8, 9, 10, 11 and 12). Liver enzymes, renal function, protein fractions, cholesterol, LDL and glucose level were not significantly affected by the *in-ovo* injection broiler eggs with fragment doses of nano-Se. While, it was found enhancement effects for inoculation nano-Se particles to the broiler eggs, where the antioxidants parameters (GSR, GSH and MDA), immune response parameters (IGG, IGM and IGA), triglycerides, HDL and T3 were improved significantly as affected by *in-ovo* injection fragment doses of

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nano-Se. Excessive reactive oxygen species (ROS) formation levels disturb the balance between oxidation and antioxidant defense systems, resulting in lipid peroxidation (Shimizu et al 2006) and oxidative damage to proteins, DNA and vital biological molecules, cause of this the antioxidant system include numerous antioxidant enzymes, such as glutathione peroxidase (GSH-Px), superoxide dismutase (SOD), and catalase (CAT) (Surai, 2002a). Natural antioxidants play vital roles in protecting cells from ROS by reducing free radicals and preventing the peroxidation of lipids (Grashorn, 2007). Selenium is an essential trace element that up regulates a major component of the antioxidant defense mechanism by controlling the body's glutathione pool and its major Se-containing antioxidant enzyme. Approximately 30–40% of selenium exist in the form of GSH-Px in animal body tissue, and lots of animal diseases and dysfunction were caused by GSH-Px activity change that aroused by selenium deficiency (Pilarczyk et al 2012). Dietary selenium is essential for the activity of virtually all arms of the immune system (Surai and Dvorska, 2002b). Feeding nano-Se increased mRNA expression of cytokine genes (interleukins 2 and 6) under both thermoneutral and high ambient temperature conditions. The balance between reactive oxygen species (ROS) production and the antioxidant system must be established to maintain immune function, health, and productivity (Surai, 2002a). (Cai et al 2012), reported that, There were no significant differences ($P>0.05$) in immune organ index (thymus, bursa, and spleen) of broiler chicks due to supplementation with nano-Se, but a significant quadratic effect of nano-Se was observed on contents of IgM in serum. (Levkut et al 2009) suggested that the effect of organic Se in increasing the concentration of circulating T and B cells is important in restoring the leukocyte subpopulation in chicks fed a deoxynivalenol (DON) contaminated diet, leading to increases in cellular phagocytic activity. Also, (Khazraie et al 2015) observed that serum total protein, globulin, AST and urea were increased linearly and quadratically in nano-Se supplemented group at 8 week of age compare to sodium selenite group, whereas, serum cholesterol, triglycerides, A/G ratio and ALP decreased.

In conclusion, in-ovo inoculation of different levels of selenium nano particles can improve feed conversion ratio, lipid profile, antioxidants status and immunity of broiler hatched chicks.

Table 1. Ingredients and calculated chemical composition of the basal diet

Ingredients	Starter	Grower
Yellow corn	58.50	62.50
Soybean meal (44%)	26.00	23.94
Maize gluten meal (62%)	10.00	7.00
Vegetable oil	1.500	2.50
Limestone	1.12	1.23
Di-Calcium Phosphate	1.75	1.70
Premix*	0.30	0.30
NaCl (salt)	0.30	0.30
L-lysine	0.36	0.36
DL-Methionine	0.17	0.17
Total	100	100
Calculated composition**		
ME (kcal kg ⁻¹)	3058.00	3120
Crude protein	22.45	20.20
Calcium	0.93	0.95
Non phytate phosphorus	0.46	0.45
Methionine	0.62	0.57
Lysine	1.28	1.2
TSAA	1.00	0.90

* Provides each Kg of diet: Vit. A: 12000 IU, Vit. D3: 5000 IU, Vit. E: 130.0 mg, Vit. K3: 3.605 mg, Vit. B1: 3.0 mg, Vit. B2: 8.0 mg, Vit. B6: 4.95 mg, Vit. B12: 0.17 mg, Niacin: 60.0 mg, Folic acid: 2.083 mg, D-Biotin: 200.0 mg, calcium D-Pantothenate: 18.333 mg, Copper: 80 mg, Iodine: 2.0 mg, Selenium: 150.0 mg, Iron: 80.0 mg, Manganese: 100.0 mg, Zinc: 80.0 mg, Cobalt 500.0 mg.

** Calculated according to NRC (1994).

Table 2. Hatchability (%), body weight at hatch (BWH) and embryonic mortality (%) of broiler chicks as affected by *in ovo* injection with doses of nano Se

Items	Hatchability (%)	Embryonic mortality (%)	Chick weight at hatch (g)
Groups			
R1	96.8 ^a	3.2 ^c	45.34
R2	93.9 ^b	6.1 ^b	45.67
R3	86.2 ^c	13.8 ^a	45.45
SEM	1.61	1.62	0.20
P value	0.00	0.00	0.790
Sig.	**	**	N.S

Mean in the same row within each classification bearing different letters are significantly different, SEM=Standard error of means, NS= non-significant, **($P\leq 0.01$).

R1= control group, R2= in-ovo injection with 5 ppm nano-selenium, R3= in-ovo injection with 10 ppm nano-selenium.

Table 3. Effect of *in ovo* injection with nano Se on live body weight (g) and body weight gain (g/bird/day) of broiler chicks at different periods

Age	Experimental groups			SEM	P value	Sig.
	R1	R2	R3			
Live body weight (g)						
Initial W.	45.5	45.7	45.5	0.27	0.955	N.S
1 st wk	153.4 ^b	166.5 ^a	165.2 ^a	2.12	0.017	*
2 nd wk	414.4	429.1	429.9	6.04	0.497	N.S
3 rd wk	789.5	837.0	837.5	9.82	0.068	N.S
4 th wk	1350.6	1368.2	1346.6	10.81	0.692	N.S
5 th wk	1936.3	2000.6	1993.8	16.7	0.221	N.S
Body weight gain (g/bird/day)						
0-1wks	15.3 ^b	17.2 ^a	17.0 ^a	0.26	0.004	**
1-2wks	37.3	37.5	37.8	0.58	0.936	N.S
2-3wks	53.6 ^b	58.3 ^a	58.2 ^a	0.62	0.001	**
3-4wks	80.1 ^a	75.9 ^b	72.7 ^c	0.59	0.000	**
4-5wks	84.0 ^b	90.35 ^a	92.46 ^a	1.10	0.001	**
0-5wks	54.1	55.8	55.7	0.47	0.241	N.S

Mean in the same row within each classification bearing different letters are significantly different, SEM=Standard error of means, NS= non-significant, *(P≤0.05), **(P≤0.01).

R1= control group, R2= in-ovo injection with 5 ppm nano-selenium, R3= in-ovo injection with 10 ppm nano-selenium.

Table 4. Effect of *in ovo* injection with nano Se on feed consumption (g/bird/day) and feed conversion (g feed/g gain) of broiler chicks at different periods

Age	Experimental groups			SEM	P value	Sig.
	R1	R2	R3			
Feed consumption (g/bird/day)						
1 st wk	18.6 ^b	20.2 ^a	21.7 ^a	0.51	0.011	*
2 nd wk	50.1 ^b	52.7 ^a	53 ^a	0.52	0.011	*
3 rd wk	79.9 ^b	87.5 ^a	81.7 ^b	1.3	0.010	**
4 th wk	124.7	121	114	1.8	0.022	*
5 th wk	136.2 ^a	128.3 ^b	138 ^a	1.7	0.010	**
Overall	81.9	82.0	81.7	7.38	0.906	N.S
Feed conversion (g feed/g gain)						
0-1wks	1.22	1.17	1.27	0.02	0.103	N.S
1-2wks	1.35	1.41	1.4	0.03	0.598	N.S
2-3wks	1.5 ^a	1.5 ^a	1.4 ^b	0.02	0.002	**
3-4wks	1.56	1.59	1.57	0.03	0.891	N.S
4-5wks	1.62 ^a	1.42 ^b	1.49 ^{a,b}	0.04	0.022	*
0-5wks	1.52	1.47	1.47	0.02	0.107	N.S

Mean in the same row within each classification bearing different letters are significantly different, SEM=Standard error of means, NS= non-significant, *(P≤0.05), **(P≤0.01).

R1= control group, R2= in-ovo injection with 5 ppm nano-selenium, R3= in-ovo injection with 10 ppm nano-selenium.

Table 5. Effect of *in ovo* injection with nano Se on carcass characteristics of broiler chicks at different periods

Items	Experimental groups			SEM	P value	Sig.
	R1	R2	R3			
Body weight (g)	1955 ^b	2020 ^a	1935.3 ^b	15.9	0.044	*
Carcass weight (%)	72.1	69.4	71.8	0.72	0.286	N.S
Heart weight (%)	0.49	0.44	0.46	0.01	0.368	N.S
Gizzard weight (%)	1.1	1.2	1.3	0.03	0.103	N.S
Liver weight (%)	2.7	2.2	2.1	0.12	0.143	N.S
Total edible weight (%)	4.2	3.9	3.8	0.11	0.205	N.S
Thigh weight (%)	28.9	28.0	29.9	0.41	0.183	N.S
Breast weight (%)	41.8	41.3	41.9	0.36	0.802	N.S
Spleen weight (%)	0.11	0.10	0.10	0.01	0.358	N.S
Thymus weight (%)	0.48	0.40	0.46	0.02	0.365	N.S
Bursa weight (%)	0.18	0.18	0.19	0.01	0.923	N.S
Carcass yield (%)	76.3	73.3	75.6	0.71	0.193	N.S

Mean in the same row within each classification bearing different letters are significantly different, SEM=Standard error of means, NS= non-significant, *(P≤0.05).

R1= control group, R2= in-ovo injection with 5 ppm nano-selenium, R3= in-ovo injection with 10 ppm nano-selenium.

Table 6. Effect of *in ovo* injection with nano Se on total protein, albumin, globulin and A/G ratio of broiler chicks in experimental groups

Items Groups	T. protien g/dl	Albumin g/dl	Globulin g/dl	A/G ratio g/dl
R1	5.6	2.9	2.7	1.09
R2	5.5	3.1	2.3	1.4
R3	6.2	3.1	3.1	1.03
SEM	0.25	0.22	0.16	0.14
P value	0.49	0.94	0.14	0.5
Sig.	N.S	N.S	N.S	N.S

Mean in the same row within each classification bearing different letters are significantly different, SEM=Standard error of means, NS= non-significant.

R1= control group, R2= in-ovo injection with 5 ppm nano-selenium, R3= in-ovo injection with 10 ppm nano-selenium.

Table 7. Effect of *in ovo* injection with nano Se on cholesterol, triglycerides, HDL-cholesterol and LDL- cholesterol of broiler chicks in experimental groups

Items Groups	Cholesterol (mg/dl)	Triglycerides (mg/dl)	HDL-Cholesterol (mg/dl)	LDL-Cholesterol (mg/dl)
R1	148.5	166.7 ^a	48 ^b	52.1
R2	121.9	128 ^b	56.6 ^a	40.5
R3	138.1	128.2 ^b	42.2 ^c	53.4
SEM	5.3	6.8	2.4	3.7
P value	0.105	0.001	0.019	0.347
Sig.	N.S	**	*	N.S

Mean in the same row within each classification bearing different letters are significantly different, SEM=Standard error of means, NS= non-significant, *(P≤0.05), **(P≤0.01).

R1= control group, R2= in-ovo injection with 5 ppm nano-selenium, R3= in-ovo injection with 10 ppm nano-selenium.

Table 8. Effect of *in ovo* injection with nano Se on transaminase and alkaline phosphatase of broiler chicks in experimental groups

Items	AST (U/L)	ALT (U/L)	ALP (U/L)
R1	146.8	30.6	142.6
R2	139.3	32.7	148.1
R3	134.2	33.8	146.2
SEM	3.9	1.3	2.9
P value	0.661	0.484	0.784
Sig.	N.S	N.S	N.S

Mean in the same row within each classification bearing different letters are significantly different, SEM=Standard error of means, NS= non-significant.

R1= control group, R2= in-ovo injection with 5 ppm nano-selenium, R3= in-ovo injection with 10 ppm nano-selenium.

Table 9. Effect of *in ovo* injection with nano Se on uric acid and creatinine of broiler chicks in experimental groups

Items	Uric Acid (mg/dl)	Creatinine (mg/dl)
R1	4.7	0.51
R2	4.5	0.52
R3	4.00	0.50
SEM	0.24	0.03
P value	0.52	0.978
Sig.	N.S	N.S

Mean in the same row within each classification bearing different letters are significantly different, SEM=Standard error of means, NS= non-significant.

R1= control group, R2= in-ovo injection with 5 ppm nano-selenium, R3= in-ovo injection with 10 ppm nano-selenium.

Table 10. Effect of *in ovo* injection with nano Se on glucose and triiodothyronine (T3) of broiler chicks in experimental groups

Items	Glucose (mg/dl)	T3 (ng/ml)
R1	224.7	0.64 ^c
R2	224.1	0.92 ^a
R3	218.7	0.73 ^b
SEM	2.21	0.04
P value	0.535	0.002
Sig.	N.S	**

Mean in the same row within each classification bearing different letters are significantly different, SEM=Standard error of means, NS= non-significant, ** (P≤0.01).

R1= control group, R2= in-ovo injection with 5 ppm nano-selenium, R3= in-ovo injection with 10 ppm nano-selenium.

Table 11. Effect of *in ovo* injection with nano Se on antioxidant status of broiler chicks in experimental groups

Items	MDA (nmol/ml)	GSH (ng/ml)	GSR (mu/ml)
R1	0.3 ^a	0.14 ^b	0.12 ^b
R2	0.13 ^b	0.17 ^a	0.17 ^a
R3	0.2 ^b	0.17 ^a	0.17 ^a
SEM	0.02	0.01	0.01
P value	0.00	0.041	0.013
Sig.	**	*	*

Mean in the same row within each classification bearing different letters are significantly different, SEM=Standard error of means, *(P≤0.05), ** (P≤0.01).

R1= control group, R2= in-ovo injection with 5 ppm nano-selenium, R3= in-ovo injection with 10 ppm nano-selenium.

Table 12. Effect of *in ovo* injection with nano Se on immunoglobulins (IgG, IgM and IgA) of broiler chicks in experimental groups

Items	IGA mg/dl	IGM mg/dl	IGG mg/dl
R1	106 ^c	75.7 ^c	799.7 ^b
R2	114.7 ^b	125.0 ^a	804.3 ^b
R3	134.7 ^a	82.0 ^b	963 ^a
SEM	4.7	8.4	30.7
P value	0.007	0.004	0.013
Sig.	**	**	*

Mean in the same row within each classification bearing different letters are significantly different, SEM=Standard error of means, *(P≤0.05), ** (P≤0.01).

R1= control group, R2= in-ovo injection with 5 ppm nano-selenium, R3= in-ovo injection with 10 ppm nano-selenium.

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التأثيرات التحسينية لحقن البيض بجزيئات السلينيوم متناهية الصغر على الأداء الإنتاجي والصفات البيوكيميائية للدم ومضادات الأكسدة والإستجابة المناعية في الكتاكيت الفاقسة

[81]

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الموجز

وهرمون T3 وإنزيم الجلوتاثيون ريدكتيز ومركب الجلوتاثيون هيدروجينيز والأجسام المناعية IGA ، IGM ، IGG في مجاميع الحقن، بينما كان هناك إنخفاض معنوي في معامل تحويل الغذاء والدهون الثلاثية ومركب المالمونالدهيد في مجاميع الحقن، بينما لم يتأثر وزن الكتكوت الفاقس وكمية الغذاء المأكول ووزن الجسم والوزن المكتسب وصفات الذبيحة وبروتينات الدم والكوليسترول وجزيئات الدهون منخفضة الكثافة وإنزيمات الكبد وحمض اليوريك والكرياتين والجلوكوز في مجاميع الحقن مقارنة بالمجموعة الضابطة، يخلص من هذه الدراسة أن حقن مستويات مختلفة من جزيئات السلينيوم متناهية الصغر يمكن أن يحسن معامل تحويل الغذاء ودهون الدم ومضادات الأكسدة والمناعة في الكتاكيت الفاقسة.

الكلمات الدالة: السلينيوم، الكتاكيت، الخصوبة

يعتبر السلينيوم عنصر ضروري في تغذية الحيوان حيث إنه يحسن إنتاج الحيوان والخصوبة والإستجابة المناعية ومضادات الأكسدة الدفاعية في الدواجن، وتهدف هذه الدراسة إلى دراسة التأثيرات النافعة لحقن البيض بجزيئات السلينيوم متناهية الصغر على الأداء الإنتاجي وسرعة تحفيز مضادات الأكسدة الدفاعية والإستجابة المناعية للكتاكيت الفاقسة - استخدم في هذه الدراسة عدد 210 بيضة بداري تسمين حيث قسمت إلى ثلاثة مجاميع معاملة ثم حقنها بجزيئات السلينيوم بتركيز (0، 5، 10 جزء في المليون) أثناء مرحلة التفريخ. تم تقييم صفات الفقس والأداء الإنتاجي وصفات الدم البيوكيميائية وبعض مضادات الأكسدة والإستجابة المناعية للكتاكيت الفاقسة، وأوضحت النتائج زيادة معنوية في جزيئات الدهون عالية الكثافة

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